New Jersey Department of Environmental Protection
Air Quality Permitting Program
Bureau of Technical Services

Technical Manual 1004

Guidelines for Compliance Stack Emission Test Programs

For technical questions on this manual, call:
Bureau of Technical Services at (609) 530-4041

E-mail: xyyyyyyy@dep.state.nj.us
Where   x – first letter of first name
            y – first seven letters of last name

July 2000

TABLE OF CONTENTS

I. INTRODUCTION

This manual is not intended to provide step-by-step instructions on preparing a stack testing protocol, observing or conducting emission tests, or preparing or reviewing emission test reports. It does contain references for specific test methods and related material.

Each protocol is source specific and will be evaluated on individual merit. Final approval will be based on the ability of the written protocol to satisfy all required testing parameters by means approved by the Bureau of Technical Services and having sound scientific basis.

Appendix II of this document contains Protocol Templates for some of the more commonly used test methods. These templates include check-off boxes and fill in the blank sections that allow one to tailor the Template to the source specific situation. You are encouraged to utilize these templates in preparing your protocol. Use of the Templates does not relieve the tester from knowing and understanding the complete method.

All testing shall be performed in accordance with the approved protocol. Unapproved deviation from the protocol is not acceptable and will be justification to require repetition of the test project.

Final test reports must contain sufficient raw data to accurately reproduce the test results. Failure to provide this data will be grounds for rejection.

II. APPLICABILITY

This guideline is intended for source operations required to perform compliance stack emission tests as a condition of Preconstruction Permit or Operating Permit, Permit renewal, Federal regulation, etc., including but not limited to:

- N.J.A.C. 7:27 and N.J.A.C. 7:26
- Title 40, CFR, Part 60
- Title 40, CFR, Part 61
- Title 40, CFR, Part 63
- Title 40, CFR, Part 264
- Title 40, CFR, Part 266

III. DEFINITIONS

Definitions of most terms are located in the appropriate test method, N.J.A.C. 7:27 Subchapter, NSPS Subpart, NESHAPS Subpart or referenced material.

BIF - Title 40, Code of Federal Regulations, Part 266; Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities.

BAQEng – NJDEP, Division of Environmental Regulation, Air Quality Permitting Program, Bureau of Air Quality Engineering

BNSR - NJDEP, Division of Environmental Regulation, Air Quality Permitting Program, Bureau of New Source Review.

BOP – NJDEP, Division of Environmental Regulation, Air Quality Permitting Program, Bureau of Operating Permits

BOP permit – an Operating Permit issued by BOP

BTS - NJDEP, Division of Environmental Regulation, Air Quality Permitting Program, Bureau of Technical Services.

CEMS - Continuous Emission Monitoring Systems.

CFR - Code of Federal Regulations.

EPA - See USEPA.

N.J.A.C. 7:27 - Chapter 27, Bureau of Air Pollution Control adopted by the Department of Environmental Protection pursuant to authority delegated at N.J.S.A. 26:2C-1 et seq. and N.J.S.A. 26:2D-1 et seq. and was filed and became effective prior to September 1, 1969.

NESHAPS - Title 40, Code of Federal Regulations, Part 61: National Emission Standards for Hazardous Air Pollutants.

NSPS - Title 40, Code of Federal Regulations, Part 60; Standards of Performance for New Stationary Sources.

PCP – Preconstruction Permit issued by BNSR or BAQEng

Stack Emission Test - A series of three valid sampling runs (per contaminant sample train), each of which shall be a minimum sampling time of one hour.

USEPA - United States Environmental Protection Agency.

IV.   PROTOCOL DEVELOPMENT & APPROVAL

Each protocol shall be developed as a site-specific document. As a rule, generic protocols are not acceptable, although the use of Protocol Templates (Appendix II) is encouraged when applicable. The protocol shall include information about the source(s), site(s), test methods, sample procedures, sample recovery and analysis, production data, report preparation, quality control and quality assurance.

A. SOURCE INFORMATION

A stack emission test protocol shall contain the following source identification information:

1. Facility name as it appears on the Permit;

2. Facility address;

3. 5-digit Program Interest or APC Plant ID Number (if available);

4. Source designation;

5. 3-digit NJ Stack Number (if applicable);

6. Permit Application Log Number (if applicable);

7. PCP of BOP Number (if applicable);

8. Facility test project coordinator's name and telephone number;

9. Brief description of the source operation;

10. Special safety requirements (special respirators, etc.) including any safety limitations on Department observers (i.e. no facial hair, etc.); and

11. A list of air contaminants to be sampled.

B. SITE INFORMATION

The protocol shall contain specific physical information concerning the sampling location(s). It is recommended that a pre-sampling investigation be performed by the contractor. The minimum information required for each sampling location is:

1. Internal stack diameter - If actual measurements are not available, estimates, based on blueprints, design specifications or other means will be acceptable; however, prior to sampling measurements must be taken and provided to the BTS on-site representative(s);

2. The number and location of sampling ports - a schematic indicating the number and location is required;

3. The upstream and downstream distances from the sampling ports to the nearest flow disturbances shall be included on the schematic;

4. The number and location of sampling points required; and

5. Approximate stack temperature, moisture, air flow rates, etc;

6. A copy of the Facility Specific requirements from the Permit.

C. METHODS INFORMATION

The protocol shall include detailed information about the sampling/analytical methodology to be utilized for each air contaminant in the test plan. Justification for choosing a specific method should be included. (*Note:* Merely listing or including a photocopy of a written method is not an acceptable alternative to a detailed protocol). The test method must be tailored to the source specific application.

If an air contaminant is affected by more than one regulation (i.e. New Jersey Air Permit and a Federal Regulation such as NSPS or NESHAPS), the methodology must be applicable to each regulation. It may be necessary to use more than one method. The method description should include:

1. The name and source of the proposed test method;

2. The approximate in-stack air contaminant concentration that represents the emission limit vs. the method detection limit;

3. A complete description of the sampling train, including materials of construction, impinger solutions and reagents;

4. Analyzer spans and approximate calibration gas values;

5. Calibration procedures for all pertinent sampling and on-site analytical equipment;

6. Sampling procedures;

7. Sample recovery procedures, including time limits for sample analysis;

8. Quality assurance/quality control measures; and

9. Any proposed deviation from the written method, including a complete justification on the necessity for the alteration. (*Note:* BTS cannot approve alterations to Federal Reference Methods required to demonstrate compliance with Federal regulations. If an individual proposes to determine compliance with a Federal regulation with a method other than specified by the EPA regulation, such request will be forwarded to EPA Region II for review).

D. PROCESS AND CONTROL PARAMETERS

The protocol shall indicate the type of information that will be monitored during stack

emission testing. This information should reflect the conditions of the PCP or BOP permit or applicable regulation. For example:

- Raw material weights or volumes;

- Air pollution control equipment parameters (pressure drops, liquid flow rates, temperatures, etc.);

- Fuel usage rates;

- Production output (quantity, linear feet, weight, megawatts, etc.); and

- Any other pertinent production related information.

As a general rule, the source should be operated at maximum production (±5%) during testing. Failure to do so could result in limits on future operation or a requirement to repeat the test program. The protocol **must** state the expected production level.

(*Note:* Any specific process/production or air pollution control equipment parameter specified in the PCP or BOP permit conditions shall be monitored during the stack emission test program. This data shall be included in the final test report).

Production/process and air pollution control equipment data is to be reported following the format included in Appendix I. This format may be altered to reflect specific production/process and air pollution control equipment items for each source operation.

E.   PROTOCOL REVIEW AND APPROVAL

BTS shall approve all air pollution control compliance protocols prior to scheduling stack emission tests.

1.   General guidelines for protocol review are:

a)   A minimum of three valid runs;

b)   A minimum sampling time of 60 minutes per run or a batch cycle, whichever is longer;

c)   If an existing stack test method is available (NJDEP or USEPA), it shall take precedence over non-validated proposed methods.

Prior to allowing non-validated proposed methods, BTS may request that the individual perform a validation study in accordance with USEPA Reference Method 301.

2.   The sequence in a BTS protocol review shall be as follows:

a)   BTS reviews the Facility Specific PCP or BOP permit requirements.

b) Review the conditions required for stack emission testing and continuous emission monitoring. If CEMS are required, separate protocols are required and they shall be installed and certified consistent with the Facility Specific requirements;

c) Determine any special conditions associated with an applicable Subchapter, Subpart or regulation;

d) Compare the application of the proposed method(s) in the protocol with the conditions of the Facility Specific requirements;

   i) The method proposed must be appropriate for the air contaminant and source, and comply with all regulations governing the test.

   ii) The detection limit of the proposed method shall be capable of demonstrating compliance with the air emission limits indicated in the PCP or BOP permit, or applicable air regulation.

   iii) Any alteration to an existing stack emission test method shall not be considered by BTS unless the reason for the alteration is to provide a means of collecting valid data that could not otherwise be obtained with the method as written; or, the method as written cannot be performed for reasons other than convenience or expense.

e) If the protocol is lacking information necessary to complete a review by BTS or if the method proposed is not appropriate, BTS will address these issues to the facility and its representatives in a written Notice of Deficiency (NOD). The NOD will indicate a time requirement for response. The time limit will be thirty days; however, BTS may extend or reduce the response time limit if the circumstances justify such action;

f) When an individual's protocol contains sufficient information, an approval letter will be issued authorizing the scheduling of a mutually acceptable stack emission test date. When considering proposed testing dates, the individual should allow a minimum of 30 calendar days for scheduling; and

g) A testing date(s) may be reserved by contacting the Supervisor, Consultant Stack Test Program. Having verbally established a testing date(s), the individual or agents thereof shall confirm their intent to test in writing, within two (2) working days of the verbal approval. Telefacsimile transmission or e-mail are acceptable written verification procedures. Failure to confirm may result in forfeiture of the schedule testing date(s).

V.   CONDUCTING & OBSERVING COMPLIANCE STACK EMISSION TESTS

The test project should begin within a reasonable time (within 2 hours) from the established scheduled start time. **Failure to do so may result in a cancellation of official testing activities for the day at the discretion of the BTS observer and will require rescheduling of a test date(s).**

The stack test is not the time to troubleshoot the equipment. Once the process is stabilized and operating at the production level necessary for compliance testing and the testing team has completed any preliminary measurements and set-up (Items 1, 2 and 3 that follow), sampling shall begin. **Adjusting or tuning the process based on real time emissions data not normally available to the equipment operators is prohibited.**

All test runs that are started should be completed unless there is a valid technical difficulty with the testing equipment (ie: failed leak check during a port change, when done) or for safety reasons. Only the Department may void a sample run for reasons other than technical difficulty with the test equipment or for safety reasons. If the facility representative feels the results from the particular run were affected by a process upset, an additional run may be conducted and an explanation must be included in the test report. Data from **all** completed test runs must be submitted, regardless of whether three runs are completed or additional runs are performed.

When conducting a stack emission test, an individual shall not deviate from their approved test protocol, unless such deviations are approved by BTS. The stack emission testing individual shall:

1.   Check all source data including:
     - stack diameter;
     - upstream/downstream diameters;
     - stack temperature, pressure, moisture and air flow.

Prior to testing, it may be necessary to alter the number of traverse points, nozzle diameter, etc. based on these actual measurements. All changes must be given to the on-site BTS observer.

2.   Provide the following information to the on-site BTS observer on the day of conducting the compliance stack emission tests:

     a)   The data from the pre-test cyclonic flow traverse.

     b)   Pre-test calibration data for all pertinent sampling equipment.

3.   Verify with the responsible individual that the source is operating at a production rate of $\pm$ 5% of that stated on the permit prior to the start of sampling or the rate agreed to in the protocol. (Note: At the discretion of the Regional Enforcement Office, any individual conducting compliance tests while operating at a production rate less than 95% of the level indicated on the permit may have its conditions changed to reflect the maximum

process rate which was achieved during testing. If the permit is conditioned for lower process rates, operating at a higher level must have prior approval, in writing, from the Regional Enforcement Office or a violation of the permit would occur, resulting in possible enforcement action against the facility. As part of the approval to return to a higher production rate, which cannot exceed the rate originally approved in the PCP or BOP permit, the Regional Enforcement Office may impose additional stack testing requirements).

4. During sampling, a representative responsible for the source operation or a representative of the consultant testing firm is required to gather process, production and air pollution control equipment information. An example of the format requested for the stack test program is shown in Appendix I. This format may be altered to conform to the needs of the specific source.

5. Set up all equipment, conduct leak checks, sample and recover samples as specified in the approved protocol.

VI.   REPORT PREPARATION & REVIEW

1. After completion of the test project, a report will be submitted to BTS within the time frame specified by the PCP or BOP permit conditions and/or enforcement document. If no time frame has been specified, then the test report shall be submitted to BTS within thirty (30) calendar days, consistent with N.J.A.C. 7:27-8.4(f)5. If additional time is required, the individual responsible for the report preparation shall contact the appropriate Regional Enforcement Office for the necessary extension.

The report shall include sufficient raw data to permit BTS staff to reproduce all results. The report shall contain the following:

- Prior facility information (Items 1 through 8 of Section IV.A. of this document);

- Source description and actual site information (diameters, dimensions, etc.);

- Summary of results, including a comparison to the permitted emission allowables;

- Production data including process and control device parameters;

- Copies of all raw field and laboratory data (including calibrations, standards, strip charts, etc.);

- Sample calculations; and

- Pre and post test equipment calibration records;

(*Note:* Failure to provide adequate information may result in rejection of the report; and thereby require a repetition of the stack emission tests).

2. All stack emission test reports must include the certification language specified in N.J.A.C. 7:27-1.39 as required by N.J.A.C. 7:27-8.15(c) or N.J.A.C. 7:27-22.18(h). The report must also be certified by a Professional Engineer or Certified Industrial Hygienist as required by N.J.A.C. 7:27-8.4(c) or N.J.A.C. 7:27-22.18(h). At the discretion of the Department, failure to provide these certifications will be justification to void the test results and require additional tests.

3. A copy of the summary of emission results with a comparison to the permitted emission allowables must be submitted to the Regional Enforcement Office having jurisdiction over the facility concurrent with the submittal of the complete test report to BTS. The summary report must be certified in the same manner as the complete test report.

4. Upon review of the stack test report, BTS may request additional data to verify the test results or source operating parameters. Failure to provide this additional data will be justification to void the test results and require additional tests.

5. Upon completion of the review of the test report by BTS, a letter will be sent to the facility indicating the findings of the review. The results of our review will also be forwarded to the appropriate Regional Enforcement Office for final disposition. Any technical questions on the findings shall be in writing and directed to the Supervisor, Consultant Test Program, BTS Questions related to the compliance status should be directed to the Regional Enforcement Office.

6. Service fees will be invoiced to the facility consistent with N.J.A.C. 7:27-8.6 or N.J.A.C. 7:27-22.31.

APPENDIX I

EMISSION TEST PRODUCTION REPORT FORM

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION

EMISSION TEST PRODUCTION REPORT FORM

Introduction

The following form has been established in order to determine operating conditions for equipment associated with stack emission tests. This form is to be completed by plant personnel during the stack sampling procedure and should accurately reflect all operations of equipment during each test run. All information supplied will be deemed as being authentic and accurate to operational conditions and will be used for determining compliance status.

The form should be submitted to the appropriate Regional Enforcement Office having jurisdiction, with a copy included in the final test report submitted to the Bureau of Technical Services.

Instructions

The information being requested on the form should be filled out completely. Failure to complete may result in invalidation of the stack test. If a particular section of the form is not applicable, write "NA" in that section. If accessory information is available or required to completely provide the mandated information, this should be attached to the form as an addendum, which should note the section on the form it pertains to. If multiple stacks are being tested, one report form should accompany each.

SECTION I -   This information should be supplied as reported in the Preconstruction Permit or Operating Permit, for the equipment being tested.

SECTION II -   Self Explanatory

SECTION III -   List all conditions that pertain to operation parameters of equipment or control apparatus. State if the required condition is being achieved, if not explain why and when it will be met. If the condition directly relates to operations during the stack test they should be recorded and listed, with time of reading, during each test run (i.e. minimum temperature requirements, CEM readout) in Section III B.

SECTION IV -   Supply the information requested for the subsection(s) which apply to the source operation. If conditions vary during each test run and/or from source to source they must be listed separately. Check the appropriate space that relates to the operating production rate during the test.

NOTE: All attempts should be made to operate at the maximum or worst case production rate. Failure to do so may require that additional tests be conducted at this rate when and if it is achievable. If not achievable, condition(s) may be placed on the operating Certificate to restrict production to reflect conditions equivalent to those during the stack test. Subsection IV A should contain a breakdown of raw materials by listing each component

individually by chemical name. Include Chemical Abstract System (CAS) # if available. List percent used corresponding to each test run. If Material Safety Data Sheets (MSDS), production strip charts or logs or other information are available which accurately give raw materials, they may be attached as supplemental addendums.

SECTION V -   Information in this section should be verified and recorded to establish the operation of the control devices from available direct readouts. These readouts should be recorded every 15 minutes. Copies of dated and signed strip charts may be used as replacement provided they clearly define the require information.

SECTION VI -   Samples may be required to be taken and analyzed by the company or representatives of the company. This analysis is required to be conducted by a state certified lab. A duplicate sample may be required by the DEP person observing the test. This sample will be analyzed by the Department for verification of analytical results.

AIR POLLUTION CONTROL REGIONAL OFFICES

CENTRAL REGIONAL OFFICE	**METROPOLITAN REGIONAL OFFICE**
PO Box 407	2 Babcock Place
Trenton, NJ 08625-0407	West Orange, NJ 07502
(609)584-4100	(973)669-3935
Fax No. (609)584-4119	Fax No. (973)669-3942
ENFORCEMENT OFFICER	ENFORCEMENT OFFICER
Joseph DePierro	*Byron Sullivan*
COUNTIES: Mercer	COUNTIES: Bergen
Middlesex	Essex
Monmounth	Hudson
Ocean	
Union	
NORTHERN REGIONAL OFFICE	**SOUTHERN REGIONAL OFFICE**
1250 Route 66	One Port Center
Parsippany-Troy Hills, NJ 07054	2 Riverside Drive
(973)299-7700	Camden, NJ 08162
Fax No. (973)299-7712	(856)614-3601
	Fax No. (856)614-3613
ENFORCEMENT OFFICER	*ENFORCEMENT OFFICER*
Michael Papp	*Edward Choromanski*
COUNTIES: Hunterdon	COUNTIES: Atlantic
Morris	Burlington
Passaic	Camden
Somerset	Cape May
Sussex	Cumberland
Warren	Gloucester
	Salem

EMISSION TEST PRODUCTION
REPORT FORM

I.   Company Name _____   APC Plant ID # _____

       Plant Location _____

       Certificate Number _____

       Designation of Equipment _____

II.   Emission Test Date(s) _____

       Tests Conducted By:

       Name of Firm _____

       Business Address _____

       Phone Number _____

          Test Team Representatives _____

                                     _____

                                       _____

                                       _____

Test Time (Start/Finish)	Run #1	Run #2	Run #3
	/	/	/

III. Permit Operating Conditions
       A. List Conditions   Achieved (Yes or No)

       _____   _____

       _____   _____

       _____   _____

       _____   _____

       _____   _____

B.   Log of Permit conditions during Stack Test
        (Record at least every 15 minutes)

CONDITION	RUN #	READOUT	TIME OF RECORDING

IV.   Equipment Operation/Process Parameters
        Number of Sources Connected _____
        Number of Sources Operating _____

Production Rate: Normal _____
                       Maximum _____

A.   Raw Materials:

	RUN #1	RUN #2	RUN #3
USAGE RATE			
lbs/hr			
BREAKDOWN			
(% by weight)			

B.   Surface Coating:

        Material Being Coated _____

        Type of Coating _____

Coating Rate (gals/hr) _____

Is Coating Altered (Yes or No) _____

With _____

Distance From Coating Head to Exhaust Duct _____

C.   Fuel Burning / Incineration:

Type of Fuel _____

Fuel Burning Rate _____ (lbs/hr), (gals/hr), (ft^3/hr)

Fuel Additives _____ % _____

Meter Reading (if available)	Time

Type of Waste Constituents _____

Auxiliary Fuel _____

Burning Rate _____

D.   Other:

Description of Operation and Process Rate

_____

_____

_____

_____

V.   Control Equipment Parameters

CEMS Required (Yes/No) _____

Contaminant? _____

_____

STACK TEST CEMS READING

Parameter Cont/Read	Parameter Cont/Read	Parameter Cont/Read	Time	Test Run #

A.   Control Equipment Performance Parameter

Parameter	Reading	Time	Run #

B.   Additional Observations

Fugitive Emissions (Yes/No) _____

Equipment Location _____

Visible Emission From Stack (Yes/No) _____

Odors Noticeable (Yes/No) _____

Vicinity of Equipment (Yes/No) _____

Near Exhaust Stack (Yes/No) _____

Off Property (Yes/No) _____

VI. Samples

Type of Sample _____

    Time of Sampling _____

    Sample By _____

    Sample Taken From _____

To Be Analyzed For _____

    Analyzed By _____

Form Information Supplied By: Name/Title (Please Print)

_____

_____

_____

_____

I certify under penalty of law that I believe the information provided in this document is true, accurate and complete. I am aware that there are significant civil and criminal penalties, including the possibility of fine or imprisonment or both, for submitting false, inaccurate or incomplete information.

Signature(s)/Date   _____

                            _____

                            _____

DEP Usage Only

Rec'd By	**Sample Rec'd Date/Time**	**Rev'd By**

APPENDIX II

PROTOCOL TEMPLATES FOR SELECTED METHODS

METHOD 1 - SAMPLE AND VELOCITY TRAVERSES
FOR STATIONARY SOURCES

Applicability and Principle

The correct selection of sampling ports and traverse points from which sampling for air pollutants will be performed will be selected pursuant to EPA Method 1. This method and BTS template are applicable only to stacks $\geq$ 12 inches internal diameter.

Stack Dimensions and Stack Gas Parameter

Internal Stack Diameter* = _____ in.

For rectangular ducts, the equivalent diameter listed above, calculated by Eqn. 1-1 of the method.

The stack dimensions are _____ in. x _____ in.

Stack Temp. (F) _____ ACFM _____ SCFM _____

Moisture (%) _____ DSCFM_____

Stack Diameters from the nearest flow disturbance (the minimum distances allowed to the nearest disturbance are two diameters downstream and one-half diameter upstream) are:

Downstream_____ Upstream_____

Note: If the minimum distances cannot be met, either a new sample location must be selected or the alternative measurement procedure in Section 11.5 of the method will be used. Specify equipment and procedures below:

Stack Diagram Detailing Sample Port Locations and Downstream/Upstream Distances:

The number of traverse/sample points will be selected as follows (*choose one*)**:**

_____ Figure 1-1 of the method for isokinetic sampling.
_____ Figure 1-2 of the method for non-isokinetic sampling.

The number of traverse points will be _____.

The location of the traverse/sample points will be selected as follows (*choose one*)**:**

_____ Table 1-2 of the method for round stacks.
_____ Table 1-1 of the method for rectangular stacks. The matrix layout will be
_____ x _____.

Sample ports will be located on a plane perpendicular to the direction of flow. For round stacks, two ports will be placed at 90 degrees to each other. For rectangular stacks, the number and location of the ports will be dictated by the chosen sample matrix (Table 1-1) and the division of the stack cross section into equal areas.

The traverse points will be located as follows. Any "adjusted" traverse points pursuant to Section 11.3.2 or 11.3.3 of the method will be noted:

Verification of the **absence of cyclonic flow** will be performed as per Section 11.4 of the method prior to the start of sampling. Documentation will be supplied to the on-site BTS observer and included in the final report.

Proposed deviations from the Method or this BTS template

(Insert any proposed deviations here)

METHOD 2 - DETERMINATION OF STACK GAS VELOCITY AND VOLUMETRIC FLOW RATE (TYPE S PITOT TUBE)

Applicability

This method is applicable for the determination of the average velocity and the volumetric flow rate of a gas stream using an S type pitot tube. This method is not applicable at measurement sites that fail to meet the criteria of Method 1, Section 11.1. Also, the method cannot be used for direct measurement in cyclonic or swirling gas streams.

Apparatus (*Check applicable*):

_____**Type S Pitot tube** made of metal tubing with an external diameter between 0.48 and 0.95 centimeters (3/16 and 3/8 inch). There shall be an equal distance from the base of each leg of the pitot to its face-opening plane. The face openings shall be aligned as shown in Figure 2-2 of the Method, however slight misalignments are permissible. The pitot shall have a known coefficient, determined as outlined in Section 10 of the Method. If a baseline coefficient value of 0.84 is assigned to the pitot tube and upon inspection does not meet the criteria set forth in Section 10 of the Method, that pitot tube will <u>not be used</u>.

_____**Standard Pitot tube.** If a standard pitot tube will be used, it must meet the specifications of Section 6.7 and 10.2 of the method. It will be checked to insure the impact holes are free from obstruction. If there are particulates in the gas stream then the steps in Section 6.1.2 of the method will be taken to insure the holes are not plugged during the test (ie. back purging of the pitot and comparing the pre and post readings).

Differential Pressure Gauge (*choose one*)

_____An inclined manometer will be used.

_____The equivalent of an inclined manometer will be used as follows:

(If another type of differential pressure gauge is used, ie. Magnahelic, etc., their calibration must be checked after each test series.)

Note: most gauges have a 10 in. (H_2O column) inclined vertical scale, having 0.01 in. H_2O divisions on the 0 to 1 in. scale, and 0.1 in. H_2O divisions on the 1 to 10 in. vertical scale. This type of manometer is acceptable for delta p values as low as 1.3 mm (0.05 in.) H_2O. **However, a gauge of greater sensitivity will be used if any of the following is found to be true:** (1) the arithmetic average of all delta p readings at the traverse points in the stack is less than 1.3 mm (0.05 in.) H_2O; (2) for traverses of 12 or more points, more than 10 percent of the individual delta p readings are below 1.3 mm (0.05 in.) H_2O, or (3) for fewer than 12 points, more than one delta p reading is below 1.3 mm (0.05 in.) H_2O.

As an alternative for the preceding three criteria, Equation 2-1 in Section 12.2 of the method can be used to determine the necessity of using a more sensitive differential pressure gauge.

Expected delta p range = _____

Inclined manometer scale = _____

An alternative flow measuring device will be used as follows:

Procedure

A pretest leak check of the pitot tube and manometer will be conducted as per Section 8.1 of the method. The manometer will be leveled and zeroed prior to use as well as periodically checked during the test.

The velocity head and temperature will be measured at each traverse point specified by EPA Method 1. The static pressure in the stack will be measured during the test as well as the atmospheric pressure. The stack gas dry molecular weight will be determined in accordance with EPA Method 3 or 3A.

Calculations

All calculations will be performed in accordance with Section 12 of the method.

Proposed deviations from this BTS Template or the Method

**METHOD 3 - GAS ANALYSIS FOR THE
DETERMINATION OF DRY MOLECULAR WEIGHT**

Applicability and Principle

This method is applicable for the determination of CO_2 and O_2 concentrations and dry molecular weight of a sample from an effluent gas stream of a fossil-fuel combustion process or other process. The sample is taken in a flexible bag and analyzed with an orsat analyzer or alternatively, with analyzers using the procedures from Method 3A.

A gas sample is extracted from a stack by either single point integrated or multi-point integrated sampling. The gas sample is analyzed for percent CO_2, O_2, and if necessary CO.

Apparatus

Pump. A leak free diaphragm-type pump, or it's equivalent, to transport the sample to the flexible bag.

Rate Meter. A rotameter, or equivalent, capable of measuring flow rate to within 2 percent of the selected flow rate will be used. A flow rate of 500 to 1000 cc/min. will be used unless another rate is required and described in the "Proposed Deviations" section of this template.

Flexible Bag. Any leak free plastic (Tedlar, Teflon, Mylar, etc.) bag or equivalent having a capacity consistent with the selected flow rate and sample time **leak checked** in accordance with Section 6.2.6 of the method.   Type of Bag _____

Pressure Gauge. A water filled U-tube manometer, or equivalent, of about 30 cm (12 in.) for the bag leak check.

Vacuum Gauge. A mercury manometer, or equivalent, of at least 760 mm (30 in.) Hg, for sampling train leak check.

 Procedure (*select one*)

_____ **Single Point Integrated**. The sampling point will be at the centroid of the cross section of the duct. The bag will be leak checked as in Section 6.2.6 of the Method. The train will be leak checked as in Section 8.2.2 of the Method. The sampling system will be purged prior to connecting the sample bag. The sample will be taken at a constant rate simultaneous with, and for the same total length of time as, each pollutant emission rate determination. At least 30 liters of sample will be taken.

_____ **Multi-Point Integrated Sampling**. The minimum number and location of the traverse points will be chosen in accordance with EPA Method 1. The procedures outlined in Sections 8.2.2 through 8.2.4 of Method 3 will be followed, except that the sample will be taken while traversing the stack from each sample point for an equal length of time.

Emission Measurement Test Procedure

Within 8 hours of collection, the sample will be analyzed for percent $CO_{2\ and}$ percent O_2 using an orsat analyzer. The orsat analyzer will be leak checked in accordance with Section 6 of the Method prior to any sample analysis. The analysis and calculations for each sample will be repeated until any three analysis differ from their mean by no more than 0.3 g/g-mole (0.3 lb/lb-mole). The three molecular weights will be averaged and reported to the nearest 0.1 lb/lb-mole.

Several compounds may interfere with the orsat analysis (ie. acid gases, unsaturated hydrocarbons, nitrous oxide and ammonia). Source specific compounds that may interfere with the orsat analysis are: _____ .

Action to be taken:

Date the orsat analyzer was checked against known O_2 and CO_2 standards _____

Alternatively, if direct analysis of the bag samples will be performed by EPA Method 3A procedures, it will be indicated here and the procedures will be included in the protocol. _____

Calculations

The calculations will be performed in accordance with Section 12 of the method.

Proposed Deviations from this BTS Template or the Method

(Insert any proposed deviations here)

METHOD 3A DETERMINATION OF CARBON DIOXIDE
AND OXYGEN FROM STATIONARY SOURCES

Applicability and Principle

A sample is continuously extracted from the effluent stream portion of the sample stream is conveyed to an instrumental analyzer(s) for the determination of CO_2 and O_2 concentrations. Performance specifications and test procedures are provided to ensure reliable data.

Apparatus

A **measurement system** for Carbon Dioxide and Oxygen that meets the specifications of this method will be used.

The **Sample Probe** will be glass, stainless steel, or equivalent, of sufficient length to traverse the sample points. The sampling probe shall be heated to prevent condensation.

The **Sample Line** will be heated (sufficient to prevent condensation) stainless steel or Teflon® tubing, to transport the sample gas to the moisture removal system.

The **Moisture Removal System** will be a refrigerator-type condenser or similar device to continuously remove condensate from the sample gas while maintaining minimal contact between the condensate and the sample gas.

The **Sample Transport Lines** will be stainless steel or Teflon tubing, to transport the sample from the moisture removal system to the sample pump, sample flow rate control, and sample gas manifold.

A **Calibration Valve Assembly** with a three-way valve assembly, or equivalent, for blocking the sample gas flow and introducing calibration gases to the measurement system at the outlet of the sampling probe when in the calibration mode will be utilized.

A **Particulate Filter**, either an in-stack or heated (sufficient to prevent water condensation) out-of-stack filter will be used. The filter will be borosilicate or quartz glass wool, or glass fiber mat. All filters will be fabricated of materials that are nonreactive to the gas being sampled.

A **Leak-free Pump**, to pull the sample gas through the system at a flow rate sufficient to minimize the response time of the measurement system will be used. The pump will be constructed of any material that is nonreactive to the gas being sampled.

A **Recorder**, a strip-chart recorder, analog computer, or digital recorder for recording measurement data. The minimum data recording requirement is one measurement value per minute.

Analytical Range

The span of the monitoring system will be selected such that the applicable gas concentration is not less than 20% of the span. If at any time during the run the measured gas concentration exceeds the span; the run will be considered invalid.

The in stack concentration is expected to be _____ for O_2.
The in stack concentration is expected to be _____ for CO_2.

The proposed analyzer span to be used during testing is _____ for O_2.
The proposed analyzer span to be used during testing is _____ for CO_2.

CALIBRATION GASES

Calibration Gases

All calibration procedures and acceptance criteria of Method 6C will be adhered to. The calibration gases will be (check one):

    ___ EPA Protocol No. 1 gases.
    ___ Gas mixtures certified by the manufacturer not to exceed $\pm2\%$ of the tag value. If this method is used, concentration verification will be performed per Section 6.1 of Method 3A and the documentation will be included in the final test report.

The calibration gases for CO_2 analyzers will be CO_2 in N_2 or CO_2 in air, or a gas mixture listed in Section 5.2 of the method.

The **zero gas** will be less than 0.25 percent of span. The zero gas concentration to be used during the source test will be _____.

The **mid-range** calibration gas will be equivalent to 40 to 60 percent of the span. The mid-range gas to be used during the source test will be _____ for O_2 and _____ for CO_2.

The **high-range** gas will be equivalent to 80 to 90 percent of the span. The high range gas to be used during the source test will be _____ for O_2 and _____ for CO_2.

Analyzer Calibration

The analyzer calibration error check will be conducted by introducing the zero, mid-range, and high-range gases to the analyzer. During this check, no adjustments to the system will be made except those necessary to achieve the correct calibration gas flow rate at the analyzer. The analyzer responses to each calibration gas will be recorded. The analyzer calibration error check will be considered invalid if the gas concentration displayed by the analyzer exceeds ±2 percent of the span for any of the calibration gases.

The sampling system bias check will be performed by introducing first an upscale gas (mid-range) at the calibration valve assembly installed at the outlet of the sampling probe, and then the zero gas. During this check, no adjustments to the system will be made except those necessary to achieve the correct calibration gas flow at the analyzer. This check will be considered invalid if the difference between the calibration error check and the calibration bias check for the same calibration gas exceeds $\pm$ 5% of the span.

Emission Measurement Test Procedure

A sample point that is representative of the source emission concentration must be selected. The sampling probe will be place at the sample point and sampling will begin at the same rate used during the bias check. A constant rate $\pm$ 10 percent will be maintained during the entire sample run. Sampling will commence only after twice the response time has elapsed.

Immediately following the completion of the test period and hourly during the test period, the zero and mid-level calibration gases will be re-introduced one at a time to the measurement system at the calibration valve assembly. No adjustments to the measurement system will be made until both the zero and calibration bias and drift checks are made. The analyzer response will be recorded. If the bias values exceed the specified limits, the test results preceding the check will be invalidated and the test will be repeated following corrections to the measurement system and full recalibration. If the drift values exceed the specified limits, the run may be accepted but the test measurement system will be fully recalibrated and the results reported using Equation 6C-1 from Method 6C.

Measurement System Performance Specifications

Zero Drift, less than or equal to $\pm$3 percent of the span value. **Calibration Drift**, less than or equal to $\pm$3 percent of span value. **Sampling System Bias**, less than or equal to $\pm$5 percent of span value. **Calibration Error**, less than or equal to $\pm$2 percent of span.

Emission Calculation

All CO_2 analyzers and O_2 analyzers that can be calibrated with zero gas will follow Section 8 of Method 6C, except all concentrations will be expressed as percent, rather than ppm. The concentrations will be calculated using Equation 6C-1 from Method 6C.

All O_2 analyzers that use a low-level calibration gas (less than 10% of span) in place of a zero gas will calculate the effluent gas concentration using the Equation 3A-1 of the method. This type of analyzer (select one)

     _____ will be used.
     _____ will not be used.

Proposed Deviations from this BTS Template or the Method

(Insert any proposed deviations here)

METHOD 4 - DETERMINATION OF MOISTURE CONTENT
IN STACK GASES

Applicability and Principle

This method is applicable for the determination of the moisture content of stack gas.

A gas sample is extracted either at a constant rate or utilizing an isokinetic sampling train; moisture is removed from the sample stream and determined either volumetrically or gravimetrically.

Apparatus

Probe. Stainless steel or glass tubing, sufficiently heated to prevent water condensation, and is equipped with either an in-stack filter (ie. glass wool plug) or heated out of stack filter as described in EPA Method 5.

Condenser. The condenser will consist of four impingers connected in series with ground glass, leak-free fittings or any similar non-contaminating fittings. The first, third and fourth impingers will be of the Greenburg-Smith design, modified by replacing the tip with a 1.3 cm. (1/2 in.) ID glass tube extending to about 1.3 cm. from the bottom of the flask. The second impinger will be of the Greenburg-Smith design with the standard tip. The first two impingers will contain known volumes of water, the third will be empty, and the fourth will contain a known weight of 6 to 16 mesh indicating type silica gel, or equivalent desiccant.

Cooling System. An ice bath container and crushed ice, or equivalent, are used to aid in condensing moisture.

Metering System. This system will include a vacuum gauge, leak-free pump, thermometers capable of measuring temperature to within 3 deg. C (5.4 deg. F) and a dry gas meter capable of measuring volume to within 2 percent.

Barometer. Mercury, aneroid or other barometer capable of measuring atmospheric pressure to within 2.5 mm Hg (0.1 in.).

Graduated Cylinder and/or **Balance**. These items are used to measure the condensed water in the impingers and silica gel to within 1 ml or 0.5g. Graduated cylinders will have subdivisions no greater than 2 ml. The balance will be capable of weighing to the nearest 0.5 g or less.

Procedure

A minimum total gas volume of 0.60 scm (21 scf) will be collected, at a rate no greater than 0.021 m^3/min (0.75 cfm). The moisture determination will be conducted simultaneous with, and for the same total length of time as, the pollutant emission rate run. The train will be set up as

shown in Figure 4-1 of the method. The probe and filter (if applicable) will be heated to about 120 deg. C (248 deg. F), to prevent water condensation ahead of the condenser. After the train is heated and the impingers iced down, a leak check will be performed with an acceptable rate of 4 percent the average sampling rate or 0.02 cfm, whichever is less. During the run the sampling rate will be maintained within 10 percent of constant rate. The dry gas meter volume will be recorded at the beginning and end of each sampling time increment and whenever sampling is halted. More ice will be added, if necessary, to maintain a temperature of less than 20 deg. C (68 deg. F) at the silica gel outlet. When the run is completed, a post leak check is performed, with the same acceptance criteria as for the pre-test leak check. The volume and weight of condensed moisture is measured to the nearest ml and 0.5 g, respectively.

      Contaminant(s) tested and sampling time _____

      Moisture train sampling time _____

In gas streams that contain water droplets, this method may produce a positive bias. If this is suspected for this source, either a wet bulb dry bulb and psychometric chart (correcting for stack pressure) or saturation and vapor pressure table determination will be conducted simultaneously with the moisture sample train, as described in the method.

The stack gas will _____ will not _____ contain moisture droplets.

Calculations

The calculations will be performed in accordance with Section 2.3 of the method.

Proposed deviations from this BTS Template or the Method

NEW JERSEY AIR TEST METHOD 1 – DETERMINATION OF PARTICULATE MATTER FROM STATIONARY SOURCES

General Applicability and Principle

Particulate matter determination requires isokinetic sampling of the exhaust stack flue gases and particulate matter is determined gravimetrically after the removal of uncombined water. The measured emission weight will be the combined weight of all particles collected and analyzed in accordance with these sampling and analytical procedures.

Required Test Data

The following test data shall be determined and reported for each run.

1) Average dry gas meter temperature (degrees Fahrenheit).
2) Average stack temperature (degrees Fahrenheit).
3) The root mean square value of differential pressures (inches of water) of all traverse points in the stack during each test run.
4) Average differential pressure (inches of water) across the orifice meter during each test run.
5) Diameter of the stack cross-sectional area at sampling location.
6) Weight (grams) of total solid particles collected during each test run.
7) Moisture content by volume in stack gas during each test run, determined by EPA Method 5 moisture procedures.
8) Volume of gas (cubic feet) sampled during each test run.
9) Source gas emission rate (SCFM).
10) Molecular weight of the stack gas, determined by EPA Method 3 or 3A.
11) Emission rate for each test run in the following units: _____

Source Specific Method Application

A minimum sample catch of 50 mg is targeted to calculate the minimum sample times. An absolute minimum of 3 mg catch is required, but any expected catch of less than 50 mg will require the use of EPA Alternative Method 005 to process the samples. Sampling times should be as close to the compliance basis (at a minimum equal to the compliance basis) as possible, while still obtaining a representative sample catch. The following equations will calculate the sample catch and the sample time.

LB/HR (from permit allowable) =   _____
DSCFM (from permit information) =   _____
Vsamp (variable to change to increase catch) =   _____ cf

gr/DSCF = (LB/HR)*7000/(60*DSCFM) =   _____
mg = (gr/DSCF)/7000*Vsamp*453.59*1000 =   _____

Sample rate (min. of 30 cf/hr) =   _____ cf/hr
Sample time (hr) = Vsamp/Sample rate =   _____
Based on these calculations, a sample time of _____ minutes/run will be performed.

Sampling Train Components

The sampling train will consist of the following:

1) A tapered-edge **sampling nozzle** constructed of stainless steel and a **glass-lined probe**.
2) **Pitot tube** with a known coefficient.
3) A **heating system** that includes **in-line thermocouples** to measure the gas stream temperature across the particulate filter. The temperature will **not exceed 225 degrees Fahrenheit** and will only be sufficiently hot to prevent condensation of water on the filter.
4) A **glass fiber filter** in a **glass holder**.
5) **Four Greenburg-Smith impingers**, the first two containing 100 ml of distilled water, the third impinger empty and the fourth containing a known quantity of silica gel, all submerged in an ice bath which will ensure that they will be kept below 68 degrees Fahrenheit. The first, third and fourth impingers will be modified Greenburg-Smith and the second will be a Greenburg-Smith impinger with a standard tip, as described in Section 6.1.1.8 of EPA Method 5.
6) A **leak-free pump** with flow control adjusters and a vacuum gauge.
7) A **dry gas meter** accurate within two percent and temperature sensors to indicate the gas inlet and outlet temperatures
8) An **orifice meter** with an inclined manometer (leveled and zeroed prior to use)
9) A **thermocouple** equipped with a temperature sensor attached to the probe adjacent to the nozzle to indicate the stack gas temperature.

All glassware will be interconnected with glass fittings having ball joints. All components will meet the specifications of the Method.

Preparation for Sampling

All internal surfaces of the nozzles, probes, impingers, connecting glassware and hoses will be cleaned and dried prior to sampling. The open ends of all sampling components will be covered to prevent contamination. A tared filter (dried at 220-230 degrees Fahrenheit, cooled in a desiccator to room temperature and weighed to the nearest 0.1mg) will be placed in the glass filter holder.

A fourth impinger will be charged with 200-300 grams of silica gel and sealed against contamination. The first and second impingers of the sampling train will be charged with 100 ml of distilled, deionized water and connected to the remaining impingers. The third impinger will be empty. The impingers will be placed in the sampling train and surrounded with crushed ice.

The entire sampling system will then be transported to the sampling site for assembly and leak check. The leak check procedure consists of assembling the sample system, starting the sampling pump and blocking the nozzle inlet. The pump is then adjusted to pull a minimum of 15 inches of mercury vacuum. When the vacuum reading stabilizes, the dry gas meter is observed for one minute to determine the sample system leak rate. If the leak rate is less than 0.02 cubic feet per minute, sampling proceeds. When the heating system reaches the proper temperature, sampling will begin.

Sampling

When the probe and filter are up to temperature, the probe will be inserted into the stack at the first traverse point with the nozzle pointed into the gas stream. The dry gas meter initial volume will be recorded and the vacuum pump will be immediately started and the flow adjusted to isokinetic conditions. For each run, the data required on Figure 5-3 of EPA Method 5 will be recorded using that or a similar data sheet. Readings indicated by Figure 5-3 will be taken at each sample point during each time increment and additional readings when significant changes necessitate additional adjustments in flow rate. Each sampling test will consist of **three separate and valid** test runs, unless otherwise specified by the Department.

Leak checks will be performed when sampling is completed at the end of each test. The dry gas meter volume will be recorded and the sample system will be leak checked. A run will be considered valid if the leak rate upon completion of the run is less than 0.02 cubic feet per minute, the final isokinetic sampling rate is between 90 and 110 percent and the filter temperature was maintained consistent with the method.

Sample Recovery Procedures

Following the completion of each test run the sampling train will be transported to a recovery area onsite. The recovery site will be clean and protected from the wind. The sample recovery will be as follows:

1)   Container 1 - Disassemble the filter housing and transfer the filter to its original glass petri dish. Seal the petri dish with Teflon tape and label it with the appropriate sample information.
2)   Container 2 - The front half of the train; nozzle, probe, and front-half filter housing are rinsed and nylon bristle brushed with acetone into an amber glass container with a Teflon-lined cap. This procedure will be performed three times or more until no visible particulate remains, after which the container is sealed and labeled. The liquid level will be marked on the container to ensure no leakage occurred during transport.
3)   The contents of the first three impingers are measured for volume and discarded.
4)   Container 3 – Note the color of the silica gel to determine whether it has been completely spent and make a notation of its condition. The silica gel is returned to its original container and weighed to obtain a final weight.
5)   Container 4 – 100 ml of acetone will taken directly from the wash bottle being used for sample recovery into a separate glass sample container and labeled "Acetone Blank".
6)   All containers are checked to ensure proper sealing, labeling, and that all liquid levels are marked. All samples are logged onto a chain-of-custody record.

Analysis

The filter will be dried at the average temperature maintained during the corresponding run and desiccated for 24 hours. The filter will be weighed to a constant weight and the final weight will be recorded to the nearest 0.1 mg. The probe and nozzle washings will be transferred to a clean, tared glass weighing dish. The dish will be evaporated at ambient temperature and pressure, then desiccated for 24 hours and weighed to the nearest 0.1 mg.

A 100 ml sample of acetone will be collected as a field blank. The blank will be evaporated at ambient temperature and pressure, then desiccated for 24 hours and weighed to the nearest 0.1 mg. The maximum

blank acetone correction will be ≤0.001% residue (by weight). This equates to a maximum blank correction of 0.0079 mg/ml of acetone rinse (0.01 mg/g acetone).

Calculations

All calculations will be carried out in accordance with the method, with all final results reported at one significant figure beyond the allowable.

QA/QC Procedure

All pitot tubes, dry gas meters, orifice meters, and thermocouples that are used in this stack test program will be properly calibrated prior to testing. Calibration records will be made available to the on-site DEP observers and submitted to the Department in the final test report.

Chain-of-custody documentation for all samples will be implemented at the completion of sampling and documented until the samples are received by the laboratory for analysis and submitted to the Department.

Proposed Deviations from this BTS Template or the Method

(Insert any proposed deviations here).

METHOD 6C - DETERMINATION OF SULFUR DIOXIDE EMISSIONS FROM STATIONARY SOURCES

Applicability and Principle

A sample is continuously extracted from the effluent stream portion of the sample stream and conveyed to an instrumental analyzer using either ultraviolet (UV), nondispersive infrared (NDIR), or fluorescence for the determination of SO_2 concentrations. Performance specifications and test procedures are provided to ensure reliable data. If a fluorescence-based analyzer is used, special calibration gases/procedures will be used as detailed in Section 5.3 of the method.

The principle of detection to be used during the test program will be _____.

Apparatus

A **measurement system** for Sulfur Dioxide that meets the specifications of this method will be used.

The **Sample Probe** will be glass, stainless steel, or equivalent, of sufficient length to traverse the sample points. The sampling probe shall be heated to prevent condensation.

The **Sample Line** will be heated (sufficient to prevent condensation) stainless steel or Teflon® tubing, to transport the sample gas to the moisture removal system.

The **Moisture Removal System** will be a refrigerator-type condenser or similar device to continuously remove condensate from the sample gas while maintaining minimal contact between the condensate and the sample gas.

The **Sample Transport Lines** will be stainless steel or Teflon tubing, to transport the sample from the moisture removal system to the sample pump, sample flow rate control, and sample gas manifold.

A **Calibration Valve Assembly** with a three-way valve assembly, or equivalent, for blocking the sample gas flow and introducing calibration gases to the measurement system at the outlet of the sampling probe when in the calibration mode will be utilized.

A **Particulate Filter**, either an in-stack or heated (sufficient to prevent water condensation) out-of-stack filter will be used. The filter will be borosilicate or quartz glass wool, or glass fiber mat. All filters will be fabricated of materials that are nonreactive to the gas being sampled.

A **Leak-free Pump**, to pull the sample gas through the system at a flow rate sufficient to minimize the response time of the measurement system will be used. The pump will be constructed of any material that is nonreactive to the gas being sampled.

A **Recorder**, a strip-chart recorder, analog computer, or digital recorder for recording measurement data. The minimum data recording requirement is one measurement value per minute.

Analytical Range

The span of the monitoring system will be selected such that a pollutant gas concentration equivalent to the emission standard is not less than 30% of the span. If at any time during the run the measured gas concentration exceeds the span; the run will be considered invalid.

Allowable = _____ lb/hr   MW = 64 lb/lbmole
Stack Flow = _____ dscfm

The in-stack concentration based on the emission standard and stack flow parameters is

$$\frac{(lb/hr) \times (387 \times 10^6)}{(MW) \times (dscfm) \times 60} = \text{_____ ppm. Therefore, the analyzer span will be _____ ppm.}$$

Calibration Gases

All calibration procedures and acceptance criteria of Method 6C will be adhered to. The calibration gases will be (check one):

___ EPA Protocol No. 1 gases.
___ Gas mixtures certified by the manufacturer not to exceed ±2% of the tag value. If this method is used, concentration verification will be performed per Section 6.1.2 of the method and the documentation will be included in the final test report.

The calibration gases will be SO_2 in N_2, or SO_2 in air, or a gas mixture listed in Section 5.3 of the method.

The **zero gas** will be less than 0.25 percent of span. The zero gas concentration to be used during the source test will be _____.

The **mid-range** calibration gas will be equivalent to 40 to 60 percent of the span. The mid range gas to be used during the source test will be _____.

The **high-range** gas will be equivalent to 80 to 90 percent of the span. The high range gas to be used during the source test will be _____.

Analyzer Calibration

The analyzer calibration error check will be conducted by introducing the zero, mid-range, and high-range gases to the analyzer. During this check, no adjustments to the system will be made except those necessary to achieve the correct calibration gas flow rate at the analyzer. The analyzer responses to each calibration gas will be recorded. The analyzer calibration error check will be considered invalid if the gas concentration displayed by the analyzer exceeds ±2 percent of the span for any of the calibration gases.

The sampling system bias check will be performed by introducing first an upscale gas (mid-range) at the calibration valve assembly installed at the outlet of the sampling probe, and then the

zero gas. During this check, no adjustments to the system will be made except those necessary to achieve the correct calibration gas flow at the analyzer. This check will be considered invalid if the difference between the calibration error check and the calibration bias check for the same calibration gas exceeds ± 5% of the span.

Emission Measurement Test Procedure

A sample point that is representative of the source emission concentration must be selected. The sampling probe will be place at the sample point and sampling will begin at the same rate used during the bias check. A constant rate ± 10 percent will be maintained during the entire sample run. Sampling will commence only after twice the response time has elapsed.

Immediately following the completion of the test period and hourly during the test period, the zero and mid-level calibration gases will be re-introduced one at a time to the measurement system at the calibration valve assembly. No adjustments to the measurement system will be made until both the zero and calibration bias and drift checks are made. The analyzer response will be recorded. If the bias values exceed the specified limits, the test results preceding the check will be invalidated and the test will be repeated following corrections to the measurement system and full recalibration. If the drift values exceed the specified limits, the run may be accepted but the test measurement system will be fully recalibrated and the results reported using Equation 6C-1.

Measurement System Performance Specifications

Zero Drift, less than or equal to ±3 percent of the span value. **Calibration Drift**, less than or equal to ±3 percent of span value. **Sampling System Bias**, less than or equal to ±5 percent of span value. **Calibration Error**, less than or equal to ±2 percent of span.

Emission Calculation

The average gas effluent concentration will be determined from the average gas concentration displayed by the gas analyzer and is adjusted for the zero and upscale sampling system bias checks, as determined in accordance with Section 7.4 of Method 6C. The average gas concentration displayed by the analyzer may be determined by integration of the area under the curve for chart recorders, or by averaging all of the effluent measurements. Alternatively, the average may be calculated from measurements recorded at equally spaced intervals over the entire duration of the run. Calculate the effluent gas concentration using Equation 6C-1.

$$C_{gas} = (\overline{C} - C_o) \frac{C_{ma}}{C_m - C_o}$$

Emissions will be presented in the following units: _____.

Proposed Deviations from this BTS Template or the Method
(Insert any proposed deviations here)

METHOD 7E - DETERMINATION OF NITROGEN OXIDE EMISSIONS FROM STATIONARY SOURCES

Applicability and Principle

A sample is continuously extracted from the effluent stream portion of the sample stream is conveyed to an instrumental chemiluminescent analyzer for the determination of NOx concentrations. Performance specifications and test procedures are provided to ensure reliable data.

Apparatus

A **measurement system** for Nitrogen Oxides that meets the specifications of this method will be used, which will include a **NO₂ to NO Converter** that converts NO_2 in the gas stream to NO.

The **Sample Probe** will be glass, stainless steel, or equivalent, of sufficient length to traverse the sample points. The sampling probe shall be heated to prevent condensation.

The **Sample Line** will be heated (sufficient to prevent condensation) stainless steel or Teflon® tubing, to transport the sample gas to the moisture removal system.

The **Moisture Removal System** will be a refrigerator-type condenser or similar device to continuously remove condensate from the sample gas while maintaining minimal contact between the condensate and the sample gas.

The **Sample Transport Lines** will be stainless steel or Teflon tubing, to transport the sample from the moisture removal system to the sample pump, sample flow rate control, and sample gas manifold.

A **Calibration Valve Assembly** with a three-way valve assembly, or equivalent, for blocking the sample gas flow and introducing calibration gases to the measurement system at the outlet of the sampling probe when in the calibration mode will be utilized.

A **Particulate Filter**, either an in-stack or heated (sufficient to prevent water condensation) out-of-stack filter will be used. The filter will be borosilicate or quartz glass wool, or glass fiber mat. All filters will be fabricated of materials that are nonreactive to the gas being sampled.

A **Leak-free Pump**, to pull the sample gas through the system at a flow rate sufficient to minimize the response time of the measurement system will be used. The pump will be constructed of any material that is nonreactive to the gas being sampled.

A **Recorder**, a strip-chart recorder, analog computer, or digital recorder for recording measurement data. The minimum data recording requirement is one measurement value per minute.

Analytical Range

The span of the monitoring system will be selected such that a pollutant gas concentration equivalent to the emission standard is not less than 30% of the span. If at any time during the run the measured gas concentration exceeds the span; the run will be considered invalid.

Allowable = _____ lb/hr   MW = 46 lb/lbmole
Stack Flow = _____ dscfm

The in-stack concentration based on the emission standard and stack flow parameters is

$$\frac{(\text{lb/hr}) \times (387 \times 10^6)}{(\text{MW}) \times (\text{dscfm}) \times 60}$$ = _____ ppm. Therefore, the analyzer span will be _____ ppm.

Calibration Gases

All calibration procedures and acceptance criteria of Method 6C will be adhered to. The calibration gases will be (check one):

___ EPA Protocol No. 1 gases.
___ Gas mixtures certified by the manufacturer not to exceed $\pm$2% of the tag value. If this method is used, concentration verification will be performed per Section 6.1 of Method 7E and the documentation will be included in the final test report.

The calibration gases will be NO in N_2.

The **zero gas** will be less than 0.25 percent of span. The zero gas concentration to be used during the source test will be _____.

The **mid-range** calibration gas will be equivalent to 40 to 60 percent of the span. The mid range gas to be used during the source test will be _____.

The high-range **gas will be equivalent to 80 to 90 percent of the span. The high range gas to be used during the source test will be _____.**

Analyzer Calibration

The analyzer calibration error check will be conducted by introducing the zero, mid-range, and high-range gases to the analyzer. During this check, no adjustments to the system will be made except those necessary to achieve the correct calibration gas flow rate at the analyzer. The analyzer responses to each calibration gas will be recorded. The analyzer calibration error check will be considered invalid if the gas concentration displayed by the analyzer exceeds $\pm$2 percent of the span for any of the calibration gases.

The sampling system bias check will be performed by introducing first an upscale gas (mid-

range) at the calibration valve assembly installed at the outlet of the sampling probe, and then the zero gas. During this check, no adjustments to the system will be made except those necessary to achieve the correct calibration gas flow at the analyzer. This check will be considered invalid if the difference between the calibration error check and the calibration bias check for the same calibration gas exceeds $\pm 5\%$ of the span.

A NO_2 to NO **converter efficiency test** will be conducted as part of this test program in accordance with Section 5.6 of Method 20.

An interference check will be conducted in accordance with Section 5.4 of Method 20 if the analyzer is new or changes have been made to the instrumentation that could affect the interference response.

Emission Measurement Test Procedure

A sample point that is representative of the source emission concentration must be selected. The sampling probe will be place at the sample point and sampling will begin at the same rate used during the bias check. A constant rate ± 10 percent will be maintained during the entire sample run. Sampling will commence only after twice the response time has elapsed.

Immediately following the completion of the test period and hourly during the test period, the zero and mid-level calibration gases will be re-introduced one at a time to the measurement system at the calibration valve assembly. No adjustments to the measurement system will be made until both the zero and calibration bias and drift checks are made. The analyzer response will be recorded. If the bias values exceed the specified limits, the test results preceding the check will be invalidated and the test will be repeated following corrections to the measurement system and full recalibration. If the drift values exceed the specified limits, the run may be accepted but the test measurement system will be fully recalibrated and the results reported using Equation 6C-1.

Measurement System Performance Specifications

Zero Drift, less than or equal to ± 3 percent of the span value. **Calibration Drift**, less than or equal to ± 3 percent of span value. **Sampling System Bias**, less than or equal to ± 5 percent of span value. **Calibration Error**, less than or equal to ± 2 percent of span.

 Emission Calculation

The average gas effluent concentration will be determined from the average gas concentration displayed by the gas analyzer and is adjusted for the zero and upscale sampling system bias checks, as determined in accordance with Section 7.4 of Method 6C. The average gas concentration displayed by the analyzer may be determined by integration of the area under the curve for chart recorders, or by averaging all of the effluent measurements. Alternatively, the average may be calculated from measurements recorded at equally spaced intervals over the entire duration of the run. Calculate the effluent gas concentration using Equation 6C-1 from Method 6C.

$$C_{gas} = (\overline{C} - C_o) \frac{C_{ma}}{C_m - C_o}$$

Emissions will be presented in the following units: _____.

Proposed Deviations from this BTS Template or the Method

(Insert any proposed deviations here)

METHOD 10 - DETERMINATION OF CARBON MONOXIDE EMISSIONS FROM STATIONARY SOURCES

Applicability and Principle

Principle. An integrated or continuous gas sample is extracted from a sampling point and analyzed for carbon monoxide (CO) content using a Luft-type nondispersive infrared analyzer (NDIR) or gas filter correlation (GFC) NDIR.

Applicability. This method is applicable for the determination of carbon monoxide emissions from stationary sources. The process will dictate whether a continuous or an integrated sample is required. If the process produces CO spikes that would exceed the span (as determined from the allowable), then an integrated procedure is required.

Interferences

Any substance having a strong absorption of infrared energy will interfere to some extent, for example water and carbon dioxide. The use of silica gel and ascarite traps will alleviate the major interference problems. The measured gas volume will be corrected if these traps are used employing Equation 10-1.

Alternatively, the use of GFC NDIR will alleviate this need.

In the sections that follow, the proposed Apparatus, Analytical Method and Sampling Procedure will be checked.

Apparatus (check one)

_____ **Continuous Sample**

> **Probe.** Stainless steel or sheathed Pyrex glass, equipped with a filter to remove particulate matter.
> **Air-Cooled Condenser or Equivalent.** To remove any excess moisture.
> **Recorder.** A strip-chart recorder, analog computer, or digital recorder for recording measurement data. The minimum data recording requirement is one measurement value per minute.

_____ **Integrated Sample**

> **Probe.** Same as above.
> **Air-Cooled Condenser or Equivalent.** Same as above.
> **Valve.** Needle valve, or equivalent, to adjust flow rate.
> **Pump.** Leak-free diaphragm type, or equivalent, to transport gas.
> **Rate Meter.** Rotameter, or equivalent, to measure a flow range from 0 to 1.0 liter per minute (0 to 0.035 cfm).
> **Flexible Bag.** Tedlar, or equivalent, with a capacity of 60 to 90 liters (2 to 3 ft^3).
> Leak-test the bag in the laboratory before using by evacuating bag with a pump followed by a dry gas meter. When evacuation is complete, there should be no flow through the meter.

Pitot Tube. Type S, or equivalent, attached to the probe so that the sampling rate can be regulated proportional to the stack gas velocity when velocity is varying with time or a sample traverse is conducted.

Analysis (check one)

_____ **NDIR Carbon Monoxide Analyzer.** Nondispersive infrared spectrometer, or equivalent. This instrument will have demonstrated, preferably by the manufacturer, to meet or exceed manufacturer's specifications and those described in this method (Addendum A).
Silica Gel and Ascarite Traps (check one)
_____ will be used as detailed in the method.
_____ will not be used **because**:

_____ **GFC Carbon Monoxide Analyzer.** Gas filter correlation NDIR analyzer. This instrument will have demonstrated, preferably by the manufacturer, to meet or exceed manufacturer's specifications and those described in this method (Addendum A).

Analytical Range

The span of the monitoring system will be selected such that it will not exceed 1.5 times the applicable source performance standard except as noted and justified in the "Proposed Deviations from this BTS Template or the Method Section" to follow. If at any time during the run the measured gas concentration exceeds the span; the run will be considered invalid.

Allowable = _____ lb/hr   MW = 28 lb/lbmole
Stack Flow = _____ dscfm

The in-stack concentration based on the emission standard and stack flow parameters is

$$\frac{(lb/hr) \times (387 \times 10^6)}{(MW) \times (dscfm) \times 60} = \underline{\hspace{1cm}} \text{ ppm. Therefore, the analyzer span will be } \underline{\hspace{2cm}} \text{ ppm.}$$

Calibration Gases

The calibration gases will be known concentration of CO in nitrogen (N_2) corresponding approximately to 30 percent (**low-range**), 60 percent (**mid-range**) and 90 percent (**high-range**) of span and a prepurified grade of N_2 for **zero**. The calibration gases will be certified by the manufacturer to be within 2 percent of the specified concentration.

The following gases will be used:

Low-range _____ ppm, **Mid-range** _____ ppm and **High-range** _____ ppm.
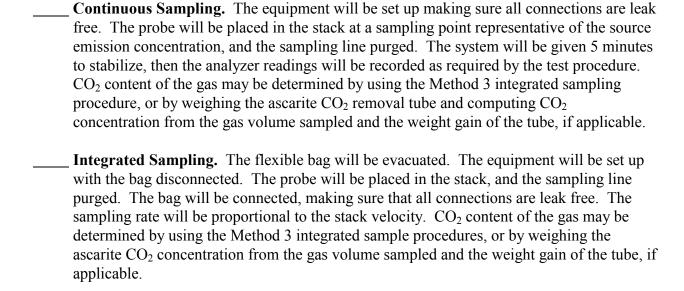
Calibration

The instrument will have a sufficiently long warm-up period to ensure stability is obtained. The manufacturer's instructions for any specific procedures will be followed. During this time the sample conditioning apparatus, i.e., filter, condenser, drying tube, and CO_2 removal tube will be checked to ensure that each component is in good operating condition. The instrument will be zeroed and calibrated according to the following procedures using, respectively, N_2 and the calibration gases.

Analyzer Calibration Error. The analyzer calibration error check will be conducted by introducing the zero, low-range, mid-range, and high-range gases to the analyzer. During this check, no adjustments to the system will be made except those necessary to achieve the correct calibration gas flow rate at the analyzer. The analyzer responses to each calibration gas will be recorded.

Sampling System Bias Check. The sampling system bias check will be performed by introducing calibration gases at the calibration valve installed at the outlet of the sampling probe. A zero gas and either the mid-range or high-range gas, whichever most closely approximates the effluent concentrations, will be introduced and the gas concentration displayed by the analyzer recorded. During the sampling system bias check, the system will be operated at the normal sampling rate, and no adjustments to the measurement system will be made, other than those necessary to achieve proper calibration gas flow rates at the analyzer.

Zero and Calibration Drift Tests. Immediately preceding and following each run, or if adjustments are necessary for the measurement system during the run, the sampling system bias check procedure described above will be repeated. No adjustments to the measurement system will be made until after the drift checks are completed.

Sampling Procedure (check one)

_____ **Continuous Sampling.** The equipment will be set up making sure all connections are leak free. The probe will be placed in the stack at a sampling point representative of the source emission concentration, and the sampling line purged. The system will be given 5 minutes to stabilize, then the analyzer readings will be recorded as required by the test procedure. CO_2 content of the gas may be determined by using the Method 3 integrated sampling procedure, or by weighing the ascarite CO_2 removal tube and computing CO_2 concentration from the gas volume sampled and the weight gain of the tube, if applicable.

_____ **Integrated Sampling.** The flexible bag will be evacuated. The equipment will be set up with the bag disconnected. The probe will be placed in the stack, and the sampling line purged. The bag will be connected, making sure that all connections are leak free. The sampling rate will be proportional to the stack velocity. CO_2 content of the gas may be determined by using the Method 3 integrated sample procedures, or by weighing the ascarite CO_2 concentration from the gas volume sampled and the weight gain of the tube, if applicable.

Emission Measurement Test Procedure

The necessary apparatus will be assembled, the instrument will be calibrated, and other required operations will be performed as described above. Analyzer will be purged with N_2 prior to introduction of each sample. The sample stream will be directed through the instrument for the test period, recording the readings.

Immediately following the completion of the test period and hourly during the test period, the zero and upscale calibration gases will be re-introduced one at a time to the measurement system at the calibration valve assembly. No adjustments to the measurement system will be made until both the zero and calibration bias and drift checks are made. The analyzer response will be recorded. If the bias values exceed the specified limits, the test results preceding the check will be invalidated and the test will be repeated following corrections to the measurement system and full recalibration. If the drift values exceed the specified limits, the run may be accepted but the test measurement system will be fully recalibrated and the results reported using Equation 6C-1 of Method 6C.

Measurement System Performance Specifications

Zero Drift, less than or equal to ±3 percent of the span value. **Calibration Drift**, less than or equal to ±3 percent of span value. **Sampling System Bias**, less than or equal to ±5 percent of span value. **Calibration Error**, less than or equal to ±2 percent of span.

Emission Calculation

The average gas effluent concentration will be determined from the average gas concentration displayed by the gas analyzer and is adjusted for the zero and upscale sampling system bias checks, as determined in accordance with Section 7.4 of Method 6C. The average gas concentration displayed by the analyzer may be determined by integration of the area under the curve for chart recorders, or by averaging all of the effluent measurements. Alternatively, the average may be calculated from measurements recorded at equally spaced intervals over the entire duration of the run. Calculate the effluent gas concentration using Equation 6C-1 from Method 6C.

$$C_{gas} = (\overline{C} - C_o) \frac{C_{ma}}{C_m - C_o}$$

Emissions will be presented in the following units: _____.

Proposed Deviations from this BTS Template or the Method

(Insert any proposed deviations here)

METHOD 25A - DETERMINATION OF TOTAL GASEOUS ORGANIC CONCENTRATION USING A FLAME IONIZATION ANALYZER

Applicability

This method is applicable for the determination of total gaseous organic concentration of vapors, **including methane**, consisting primarily of alkanes, alkenes, and/or arenes (aromatic hydrocarbons). The emissions are **expressed in terms of methane** unless the permit states otherwise.

Summary of Method

A gas sample is extracted from the source through a heated sample line and glass fiber filter to a flame ionization analyzer (FIA). Results are reported as volume concentration equivalents of the calibration gas. If the calibration gases are not methane, results will be corrected to a methane basis by use of a response factor, unless the permit limit states a basis other than methane.

Apparatus

Measurement System. Any measurement system for total organic concentration that meets the specifications of this method. All sampling components leading to the analyzer will be heated $\geq$ 110EC (220EF) throughout the sampling period, unless safety reasons are cited.

Organic Concentration Analyzer. A flame ionization analyzer (FIA) capable of meeting or exceeding the specifications of this method. The flame ionization detector block will be heated >120EC (250EF).

Sample Probe. Stainless steel, or equivalent, three-hole rake type. Sample holes will be 4 mm (0.16-in.) in diameter or smaller and located at 16.7, 50, and 83.3 percent of the equivalent stack diameter. Alternatively, a single opening probe may be used so that a gas sample is collected from the centrally located 10 percent area of the stack cross-section.

Heated Sample Line. Stainless steel or Teflon® tubing to transport the sample gas to the analyzer. The sample line should be heated ($110 EC) to prevent any condensation.

Calibration Valve Assembly. A three-way valve assembly to direct the zero and calibration gases to the analyzers is recommended. Other methods, such as quick-connect lines, to route calibration gas to the analyzers are acceptable.

Particulate Filter. An in-stack or an out-of-stack glass fiber filter is required except as explained and justified in the Proposed Deviation from the Method Section. An out-of-stack filter should be heated to prevent any condensation.

Recorder. A strip-chart recorder, analog computer, or digital recorder for recording measurement data. The minimum data recording requirement is one measurement value per minute.

Analytical Range

The span value should be between 1.5 to 2.5 times the applicable in-stack concentration based on the emission limit.

Allowable = _____ lb/hr   MW = _____ lb/lbmole
Stack Flow = _____ scfm

The in-stack concentration based on the emission standard and stack flow parameters is

$$\frac{(lb/hr) \times (387 \times 10^6)}{(MW) \times (scfm) \times 60} = \text{_____ ppm. Therefore, the analyzer span will be _____ ppm.}$$

Calibration Gases

The calibration gases for the gas analyzer will be methane in air or methane in nitrogen. Alternatively, organic compounds other than methane can be used; the appropriate corrections for response factor must be made. The calibration gases will be _____.
Calibration gases will be EPA Protocol No. 1 gases and will include a recommended shelf-life from the manufacturer over which the concentration does not change more than $\pm$ 2% from the certified value.

Zero Gas. High purity air with less than 0.1 part per million by volume (ppmv) of organic material (methane or carbon equivalent) or less than 0.1 percent of the span value, whichever is greater.

Low-level Calibration Gas. An organic calibration gas with a concentration equivalent to 25 to 35 percent of the applicable span value. The low-level gas to be used during the source test will be _____.

Mid-level Calibration Gas. An organic calibration gas with a concentration equivalent to 45 to 55 percent of the applicable span value. The mid-level gas to be used during the source test will be _____.

High-level Calibration Gas. An organic calibration gas with a concentration equivalent to 80 to 90 percent of the applicable span value. The high-level gas to be used during the source test will be _____.

Analyzer Calibration

The calibration procedures described in Method 6C (calibration error, bias and drift) will be followed unless deemed not feasible and approved by the on-site BTS observer.

The analyzer calibration error check will be conducted by introducing the zero, low-range, mid-range, and high-range gases to the analyzer. During this check, no adjustments to the system will

be made except those necessary to achieve the correct calibration gas flow rate at the analyzer. The analyzer responses to each calibration gas will be recorded. The analyzer calibration error check will be considered invalid if the gas concentration displayed by the analyzer exceeds ±2 percent of the span for any of the calibration gases.

The sampling system bias check will be performed by introducing first an upscale gas (mid-range) at the calibration valve assembly installed at the outlet of the sampling probe, and then the zero gas. During this check, no adjustments to the system will be made except those necessary to achieve the correct calibration gas flow at the analyzer. This check will be considered invalid if the difference between the calibration error check and the calibration bias check for the same calibration gas exceeds ± 5% of the span.

Alternatively, **if approved by the BTS observer**, the following calibration error test will be performed. Immediately prior to the test series (within 2 hours of the start of the test), zero gas and high-level calibration gas will be introduced at the calibration valve assembly. The analyzer output will be adjusted to the appropriate levels, if necessary. The predicted response will be calculated for the low-level and mid-level gases based on a linear response line between the zero and high-level response. Then the low-level and mid-level calibration gases will be introduced successively to the measurement system. The analyzer responses will be recorded for low-level and mid-level calibration gases and the differences between the measurement system responses and the predicted responses determined. These differences must be less than 5 percent of the respective calibration gas value. If not, the measurement system is not acceptable and will be replaced or repaired prior to testing. No adjustments to the measurement system will be made after the calibration and before the drift check. If adjustments are necessary before the completion of the test series, drift checks will be performed prior to the required adjustments and the calibration following the adjustments repeated. If multiple electronic ranges are to be used, each additional range will be checked with a mid-level calibration gas to verify the multiplication factor.

Response Time Test. Zero gas will be introduced into the measurement system at the calibration valve assembly. When the system output has stabilized, switch quickly to the high-level calibration gas. The time will be recorded from the concentration change to the measurement system response equivalent to 95 percent of the step change. The test will be repeated three times and the results averaged.

Emission Measurement Test Procedure

Organic Measurement. Sampling will begin at the start of the test period at a sample point that is centrally located in the stack. The time and any required process information will be recorded, as appropriate, in particular, noting on the recording chart, periods of process interruption or cyclic operation.

Bias and Drift Determination. Immediately following the completion of the test period and hourly during the test period, the zero and mid-level calibration gases will be re-introduced one at a time to the measurement system at the calibration valve assembly. No adjustments to the measurement system will be made until both the zero and calibration bias and drift checks are made. The analyzer response will be recorded. If the bias values exceed the specified limits, the

test results preceding the check will be invalidated and the test will be repeated following corrections to the measurement system and full recalibration. If the drift values exceed the specified limits, the run may be accepted but the test measurement system will be fully recalibrated and the results reported using Method 6C correction. If the alternative calibration error test was approved, both sets of calibration data (i.e., data determined prior to the test period and data determined following the test period).

Measurement System Performance Specifications

Zero Drift, less than or equal to ±3 percent of the span value. **Calibration Drift**, less than or equal to ±3 percent of span value. **Calibration Error**, less than or equal to ±2 percent of span for Method 6C procedures, less than or equal to ±5 percent of the calibration gas value for the alternative procedures. **Sampling System Bias**, less than or equal to ±5 percent of the calibration gas value for Method 6C procedures.

Emission Calculation

Calculations will be done per the method including Method 6C (Equation 6C-1) drift corrections. Emissions will be presented in the following units: _____.

Proposed Deviations from this BTS Template or the Method

(Insert any proposed deviations here)

METHOD 25B - DETERMINATION OF TOTAL GASEOUS ORGANIC CONCENTRATION USING A NONDISPERSIVE INFRARED ANALYZER

Applicability

This method is applicable for the determination of total gaseous organic concentration of vapors consisting primarily of alkanes. Other organic materials may be measured using the general procedure in this method, the appropriate calibration gas, and an analyzer set to the appropriate absorption band.

Summary of Method

A gas sample is extracted from the source through a heated sample line, if necessary, and glass fiber filter to a nondispersive infrared analyzer (NDIR). Results are reported as volume concentration equivalents of the calibration gas or as carbon equivalents.

Explosive Atmosphere - This method is often applied in highly explosive areas. Caution and care will be exercised in the choice of equipment and installation.

Apparatus

Measurement System. Any measurement system for total organic concentration that meets the specifications of this method. All sampling components leading to the analyzer will be heated $\geq$ 110EC (220EF) throughout the sampling period, unless safety reasons are cited.

Organic Concentration Analyzer. A nondispersive infrared analyzer designed to measure alkane organics and capable of meeting or exceeding the specifications in this method.

Sample Probe. Stainless steel, or equivalent, three-hole rake type. Sample holes will be 4 mm (0.16-in.) in diameter or smaller and located at 16.7, 50, and 83.3 percent of the equivalent stack diameter. Alternatively, a single opening probe may be used so that a gas sample is collected from the centrally located 10 percent area of the stack cross-section.

Heated Sample Line. Stainless steel or Teflon® tubing to transport the sample gas to the analyzer. The sample line should be heated ($110 EC) to prevent any condensation.

Calibration Valve Assembly. A three-way valve assembly to direct the zero and calibration gases to the analyzers is recommended. Other methods, such as quick-connect lines, to route calibration gas to the analyzers are acceptable.

Particulate Filter. An in-stack or an out-of-stack glass fiber filter is required except as explained and justified in the Proposed Deviation from the Method Section. An out-of-stack filter should be heated to prevent any condensation.

Recorder. A strip-chart recorder, analog computer, or digital recorder for recording

measurement data. The minimum data recording requirement is one measurement value per minute.

Analytical Range

The span value should be between 1.5 to 2.5 times the applicable in-stack concentration based on the emission limit.

Allowable = _____ lb/hr   MW = _____ lb/lbmole
Stack Flow = _____ scfm

The in-stack concentration based on the emission standard and stack flow parameters is

$$\frac{(lb/hr) \times (387 \times 10^6)}{(MW) \times (scfm) \times 60} = \text{_____} \text{ ppm.}$$ Therefore, the analyzer span will be _____ ppm.

Calibration Gases

The calibration gases for the gas analyzer will be propane in air or propane in nitrogen. Alternatively, organic compounds other than propane can be used; the appropriate corrections for response factor must be made. The calibration gases will be _____.
Calibration gases will be EPA Protocol No. 1 gases and will include a recommended shelf-life from the manufacturer over which the concentration does not change more than $\pm$ 2% from the certified value.

Zero Gas. High purity air with less than 0.1 part per million by volume (ppmv) of organic material (methane or carbon equivalent) or less than 0.1 percent of the span value, whichever is greater.

Low-level Calibration Gas. An organic calibration gas with a concentration equivalent to 25 to 35 percent of the applicable span value. The low-level gas to be used during the source test will be _____.
Mid-level Calibration Gas. An organic calibration gas with a concentration equivalent to 45 to 55 percent of the applicable span value. The mid-level gas to be used during the source test will be _____.

High-level Calibration Gas. An organic calibration gas with a concentration equivalent to 80 to 90 percent of the applicable span value. The high-level gas to be used during the source test will be _____.

Analyzer Calibration

The calibration procedures described in Method 6C (calibration error, bias and drift) will be followed unless deemed not feasible and approved by the on-site BTS observer.

The analyzer calibration error check will be conducted by introducing the zero, low-range, mid-

range, and high-range gases to the analyzer. During this check, no adjustments to the system will be made except those necessary to achieve the correct calibration gas flow rate at the analyzer. The analyzer responses to each calibration gas will be recorded. The analyzer calibration error check will be considered invalid if the gas concentration displayed by the analyzer exceeds ±2 percent of the span for any of the calibration gases.

The sampling system bias check will be performed by introducing first an upscale gas (mid-range) at the calibration valve assembly installed at the outlet of the sampling probe, and then the zero gas. During this check, no adjustments to the system will be made except those necessary to achieve the correct calibration gas flow at the analyzer. This check will be considered invalid if the difference between the calibration error check and the calibration bias check for the same calibration gas exceeds $\pm$ 5% of the span.

Alternatively, **if approved by the BTS observer**, the following calibration error test will be performed. Immediately prior to the test series (within 2 hours of the start of the test), zero gas and high-level calibration gas will be introduced at the calibration valve assembly. The analyzer output will be adjusted to the appropriate levels, if necessary. The predicted response will be calculated for the low-level and mid-level gases based on a linear response line between the zero and high-level response. Then the low-level and mid-level calibration gases will be introduced successively to the measurement system. The analyzer responses will be recorded for low-level and mid-level calibration gases and the differences between the measurement system responses and the predicted responses determined. These differences must be less than 5 percent of the respective calibration gas value. If not, the measurement system is not acceptable and will be replaced or repaired prior to testing. No adjustments to the measurement system will be made after the calibration and before the drift check. If adjustments are necessary before the completion of the test series, drift checks will be performed prior to the required adjustments and the calibration following the adjustments repeated. If multiple electronic ranges are to be used, each additional range will be checked with a mid-level calibration gas to verify the multiplication factor.

Response Time Test. Zero gas will be introduced into the measurement system at the calibration valve assembly. When the system output has stabilized, switch quickly to the high-level calibration gas. The time will be recorded from the concentration change to the measurement system response equivalent to 95 percent of the step change. The test will be repeated three times and the results averaged.

Emission Measurement Test Procedure

Organic Measurement. Sampling will begin at the start of the test period at a sample point that is centrally located in the stack. The time and any required process information will be recorded, as appropriate, in particular, noting on the recording chart, periods of process interruption or cyclic operation.

Bias and Drift Determination. Immediately following the completion of the test period and hourly during the test period, the zero and mid-level calibration gases will be re-introduced one at a time to the measurement system at the calibration valve assembly. No adjustments to the

measurement system will be made until both the zero and calibration bias and drift checks are made. The analyzer response will be recorded. If the bias values exceed the specified limits, the test results preceding the check will be invalidated and the test will be repeated following corrections to the measurement system and full recalibration. If the drift values exceed the specified limits, the run may be accepted but the test measurement system will be fully recalibrated and the results reported using Method 6C correction. If the alternative calibration error test was approved, both sets of calibration data (i.e., data determined prior to the test period and data determined following the test period).

Measurement System Performance Specifications

Zero Drift, less than or equal to ±3 percent of the span value. **Calibration Drift**, less than or equal to ±3 percent of span value. **Calibration Error**, less than or equal to ±2 percent of span for Method 6C procedures, less than or equal to ±5 percent of the calibration gas value for the alternative procedures. **Sampling System Bias**, less than or equal to ±5 percent of the calibration gas value for Method 6C procedures.

Emission Calculation

Calculations will be done per the method including Method 6C (Equation 6C-1) drift corrections.
 Results will be reported (select one):

     ___ as propane.
     ___ as methane by multiplying concentrations by 3.

Emissions will be presented in the following units: _____.

Proposed Deviations from this BTS Template or the Method

(Insert any proposed deviations here)

METHOD 29 – DETERMINATION OF METALS EMISSIONS FROM STATIONARY SOURCES

Check Applicable Analyte	Analyte	Check Applicable Analytical Method Principle			
		ICAP	AAS	GFAAS	ICAP-MS
	Antimony (Sb)				
	Arsenic (As)				
	Barium (Ba)				
	Beryllium (Be)				
	Cadmium (Cd)				
	Chromium (Cr)				
	Cobalt (Co)				
	Copper (Cu)				
	Lead (Pb)				
	Manganese (Mn)				
	Mercury (Hg)				
	Nickel (Ni)				
	Phosphorus (P)				
	Selenium (Se)				
	Silver (Ag)				
	Thallium (Tl)				
	Zinc (Zn)				

Note: The following is only a summary of Method 29 that highlights important aspects of the test methodology. Unless otherwise noted, procedures (i.e. sample train construction, sample recovery, sample preparation, reagents and standards, analytical technique, standards, QA/QC samples, calculations) will strictly be conducted as specified within the most current EPA Method 29 version.

Applicability

This method is applicable to the determination of metals emissions from stationary sources (See previous list). We are aware that the NJDEP does not allow particulate sampling to be combined with the Method 29 train.

Principle

A stack sample is withdrawn isokinetically from the source, particulate emissions are collected in the probe and on a heated filter, and gaseous emissions are then collected in an aqueous acidic solution of hydrogen peroxide (analyzed for all metals including Hg) and an aqueous acidic solution of potassium permanganate (analyzed only for Hg). The recovered samples are digested, and appropriate fractions are analyzed using an analytical method with a sufficient detection limit to demonstrate compliance, as detailed on the previous page.

Interferences

Iron (Fe) can be a spectral interference during the analysis of As, Cr, and Cd by ICAP. Aluminum (Al) can be a spectral interference during the analysis of As and Pb by ICAP. Generally, diluting the analytical sample can reduce these interferences, but such dilution raises the in-stack detection limits. Background and overlap corrections may be used to adjust for spectral interferences. Refer to Method 6010 of Reference 2 in Section 16.0 or the other analytical methods used for details on potential interferences to this method. For all GFAAS analyses, use matrix modifiers to limit interferences, and matrix match all standards.

> Based on the above we (appropriate box checked):
> _____ Do not expect any interference.
> _____ Do expect interference. The description and discussion of the anticipated interference follows.

In–Stack Detection Limits & Sample Times

Actual in-stack method detection limits (ISDL) are based on actual source sampling parameters and analytical results. Actual detection limits can be improved through increased stack gas sampled (sample time), reducing the total volume of the digested samples, improving the analytical detection limits or any combination of the three.

The goal of the sample program will be to have the in-stack detection limit at 1/10 the permit allowable expressed as the in-stack concentration limit (ISCL). The ratio of ISCL/ISDL should be ≥ 10. The following will detail these determinations and will establish the sampling time.

ISDL Calculations for each Analyte

$$\text{ISDL (ug/m}^3) = A/C \times (B_F + B_B) / 1000$$

Where: A = analytical detection limit (ng/ml)
B_F = amount of analyte analyzed, front half (ml, default = 300)
B_B = amount of analyte analyzed, back half (ml, default = 150)
C = volume of stack gas sampled (m^3, 1.25 m^3 for each hour)

In-Stack Concentration Limit (ISCL)

$$\text{ISCL (ug/m}^3) = E/F \times 2.67\text{E}8$$

Where: E = permit allowable (lb/hr)
F = stack flow rate (dscfm)

B_F = _____ B_B = _____ C = _____ F = _____

ANALYTE	A	E	ISDL	ISCL	ISCL/ISDL
Antimony (Sb)					
Arsenic (As)					
Barium (Ba)					
Beryllium (Be)					
Cadmium (Cd)					
Chromium (Cr)					
Cobalt (Co)					
Copper (Cu)					
Lead (Pb)					
Manganese (Mn)					
Mercury (Hg)*					
Nickel (Ni)					
Phosphorus (P)					
Selenium (Se)					
Silver (Ag)					
Thallium (Tl)					
Zinc (Zn)					

*Front-half ISDL calculated by $(A \times B_F)/C$. Back-half ISDL estimated at 0.5 ug/m^3. See Sections 13.2 and 11.1.3 of Method 29.
Based on the preceding, each sample run will be _____ minutes.

Sample Train & Recovery Components & Supplies

A schematic of the sampling train is shown in Figure 29-1 of the method. It has general similarities to that of EPA Method 5. Specifically, the sampling train will be constructed with components specified under EPA Method 29, Section 6.0, with the following exceptions and highlights.

No metal components will be used, eliminating potential for metal contamination

Sample Train
1) **Probe liner** and **nozzle** will be constructed of glass (Borosilicate or Quartz) or Teflon. A single glass piece consisting of a combined probe tip and probe liner may be used.
2) Sample **filters** will be constructed of quartz or glass fiber containing less than 1.3 $\mu g/in^2$ of each of the metals to be measured. Analytical results provided by filter manufacturers stating metals content of the filters are acceptable.
3) The **glass filter holder**, same as Method 5, Section 6.1.1.5, except a **Teflon filter support or other non-metallic support** will be used.
4) The **impinger train** (for condensing and collecting gaseous metals and determining the moisture content of the stack gas) will consist of four to seven impingers connected in series with leak-free ground glass fittings or other leak-free, non-contaminating fittings. The first impinger is used as a moisture trap. The second impinger (which is the first HNO_3/H_2O_2, 5 Percent HNO_3/10 Percent H_2O_2, impinger) will be identical to the first impinger in Method 5. The third impinger (which is the second HNO_3/H_2O_2 impinger) will be a Greenburg Smith impinger with the standard tip as described for the second impinger in Method 5, Section 6.1.1.8. The fourth (empty) impinger and the fifth and sixth (both containing acidified $KMnO_4$, 4 Percent $KMnO_4$ (W/V), 10 Percent H_2SO_4 (V/V)) impingers are the same as the first impinger in Method 5. A temperature sensor capable of measuring to within 1^oC (2^oF) will be placed at the outlet of the last impinger. If no Hg analysis is planned, then the fourth, fifth, and sixth impingers are not used. For this test program, the fourth, fifth and sixth impingers (choose one) *will / will not* be used.
5) **Teflon Tape** will be used for capping openings and sealing connections, if necessary, on the sampling train.

Sample Recovery
1) During sample recovery **non-metallic brushes or swabs** for quantitative recovery of materials collected in the front-half of the sampling train.
2) **Glass bottles with Teflon-lined caps** that are non-reactive to the oxidizing solutions, with capacities of 1000- and 500-ml, for storage of acidified $KMnO_4$-containing samples and blanks. Glass or polyethylene bottles may be used for other sample types.
3) **Polypropylene Tweezers and/or Plastic Gloves**. Used for recovery of the filter from the sampling train filter holder.

Pre-Test Preparation & Train Assembly

Pre-test preparation will follow the same general procedures given in Method 5, Section 4. All sampling train glassware will be rinsed with hot tap water and then wash in hot soapy water. Next, glassware will be rinsed three times with tap water, followed by three additional rinses with water. Finally, all glassware will be soaked in a 10 percent (V/V) nitric acid solution for a minimum of 4 hours, rinsed three times with water, rinsed a final time with acetone, and allowed to air dry. All glassware openings will be covered where contamination can occur until the sampling train is assembled for sampling.

The sampling train will be set up as shown in Figure 29-1 of the method. The same general procedures given in Method 5 will be followed, except 100 ml of the HNO_3/H_2O_2 solution will be placed in each of the second and third impingers. 100 ml of the acidic $KMnO_4$ absorbing solution will be placed in each of the fifth and sixth impingers, and approximately 200 to 300 g of pre-weighed silica gel will be transferred from its container to the last impinger.

If Hg analysis will not be performed, the fourth, fifth, and sixth impingers will not be used, if so indicated in the previous section.

Sampling

Pre-test leak checks will be conducted followed by three (3) separate and valid isokinetic test runs performed as specified by the procedures given in EPA Method 5. A leak check will be considered valid if the leakage rate is found to be no greater than 0.020 cfm (0.00057 m^3/min) or 4 percent of the average sampling rate (whichever is less). If sampling for Hg, procedures analogous to those described in Section 8.1 of Method 101A, 40 CFR Part 61, Appendix B, will be followed in order to maintain the desired color in the last acidified permanganate impinger. For each run, all required data will be recorded on a data sheet similar to the one shown in Method 5.

Post test leak checks will be conducted at the completion of each test run, with the same acceptance criteria as the pre-test leak check. If the final leak checks are acceptable, then the isokinetic percentages will be calculated as described in Method 5, with an acceptance criteria of 90 to 110 percent.

Sample Recovery

At the completion of each test run the entire sample train will be taken to a **sheltered and contamination free cleanup site**. First, the impingers will be weighed for moisture determination and the following sample fractions will be recovered. All containers will be clearly labeled and the height of all fluid levels will be marked to ensure no leakage occurred during sample transport. We will also refer to Figure 2, entitled Sample Recovery Scheme, as a general outline.

*Note: We understand the use of the exact method specified rinse volumes is necessary for the subsequent blank correction procedures.

1) Filter removed carefully and placed into petri dish labeled Container No. 1.
2) No Container No. 2 because particulate not determined in this sample train.
3) Probe, nozzle, and front-half glassware rinsed three times with a total of 100 ml of 0.1N HNO_3 – All placed into a single storage Container No. 3.
4) Contents of two HNO_3/H_2O_2 impingers and the moisture knockout impinger placed in a container and the volume recorded. Clean each of the three impingers (referring to the 1st originally empty impinger and the 2nd and 3rd impingers containing HNO_3/H_2O_2, when a total of 7 impingers are used), the back half of the filter housing, and connecting glassware rinsed three times with a total volume of 100 ml of 0.1 N HNO_3 and label Container No. 4.

When sampling for Hg, steps 5, 6 and 7 are performed.

5) Pour all liquid from the impinger preceding the permanganate impingers (impinger No. 4 when a total of 7 impingers are used) into Container No. 5A. Three rinses using a total of exactly 100 ml of 0.1 N HNO_3 are then placed into the same container.
6) Place the liquid from the permanganate impingers (impinger Nos. 5 and 6 when a total of 7 impingers used) into Container No. 5B. Three rinses of the impingers and connecting glassware using a total of exactly 100 ml of $KNnO_4$ are then placed in the same container. Place three additional rinses of the impingers and connecting glassware, totaling 100 ml, of water into the same container.
7) The permanganate impingers are then rinsed using a total of 25 ml of 8 N HCl. This wash will be placed into a container containing 200 ml of water and labeled Container No. 5C. We understand that this fraction is **required** unless specifically waived by an observer from the Department.
8) Silica gel will be placed into Container No. 6. The color of the indicating silica gel will be noted and recorded on the data sheet to determine whether it has been completely spent.

Blank samples for QA/QC purposes, as specified in the method, will be collected in the field and labeled appropriately.

Sample Preparation & Analysis

Sample preparation and analysis will be conducted strictly as specified in Method 29 and the selected analytical method(s). Special attention will be paid to all required QA/QC procedures. On at least one sample run in the source test, and for each metal analyzed, repetitive analysis, Method of Standard Additions, serial dilutions or matrix spike addition will be performed to document the quality of the data.

All analytical fractions will be analyzed **separately**, per the method. We are aware that the NJDEP does not allow the combination of Analytical Fractions 1A and 2A.

Calculations

All calculations will be performed as per Method 29, including blank corrections. Detailed sample calculations will be included in the final report.

Emissions will be presented in the following units: _____.

Proposed Deviations From This BTS Template Or The Method

(Insert any proposed deviations here)